Evader Movement in a Visibility-Based Pursuit-Evasion Problem

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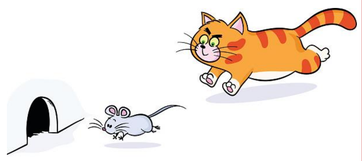
Visibility-Based Pursuit-Evasion

- One or more pursuers try to systematically catch all evaders in the environment.
- A pursuer has a visibility region that extends in all directions until its line of sight is interrupted by an obstacle or edge.
- Evaders hide from pursuers in shadows where they are not visible. An evader is caught if it enters the region of sight of a pursuer.
- A shadow is **contaminated** if an evader may be hiding in it, and it is **clear** if it is guaranteed that an evader is not in the shadow.



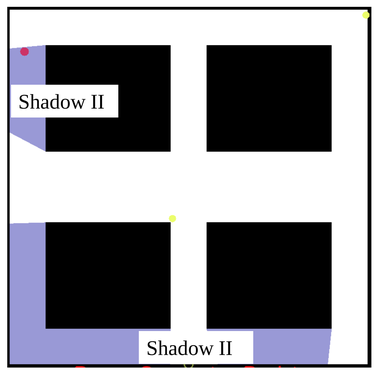
Objective

Good News: Existing algorithms produce paths for all pursuers to follow that guarantee the capture of all evaders.

Bad News: Little time has been spent analyzing and creating paths for evaders.

Motivation: The goal is to compare possible strategies of movement for the evader with the intention of developing automated movement.

Methods



Two Areas of Research:

- The simulation was amended to give a human control of the evader's path and manually produce strategies.
- The algorithm was improved to include code that automatically produced its own strategies.
- Both types of movement were tested in the same environment.

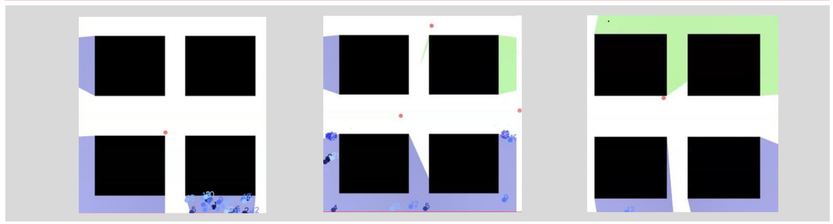
Human-Controlled Evader Movement

- The evader is represented in the simulation as a circle and is controllable by pressing the arrow keys on a computer keyboard.
- The movement is constrained within the polygonal environment and the evader must move in a continuous path.
- This allows for humans to attempt to create a **successful** motion strategy that prevents the evader from becoming visible for as long as possible.

Automated Evader Movement

- The algorithm was enhanced to include code that generates movement strategies without human input.
- The code was written to keep the evader moving towards the center of the shadow that contains it.
- By chasing the center of the shadow, the evader must make decisions at shadow events.

Algorithm Additions



While the evader is moving throughout the environment, its position is recorded and written as an ordered pair to a text file. These files make it possible to replay single or multiple runs. This allows for comparison between movement strategies.

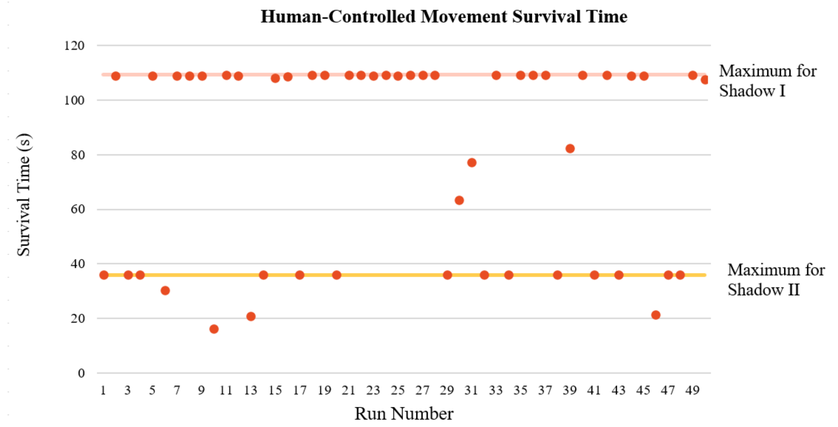
Watch the Simulations

SCAN ME

Scan to view simulations of:

- Multiple Automated Evader Movement
- Multiple Human-Controlled Evader Movement
- Single Human-Controlled Evader Movement

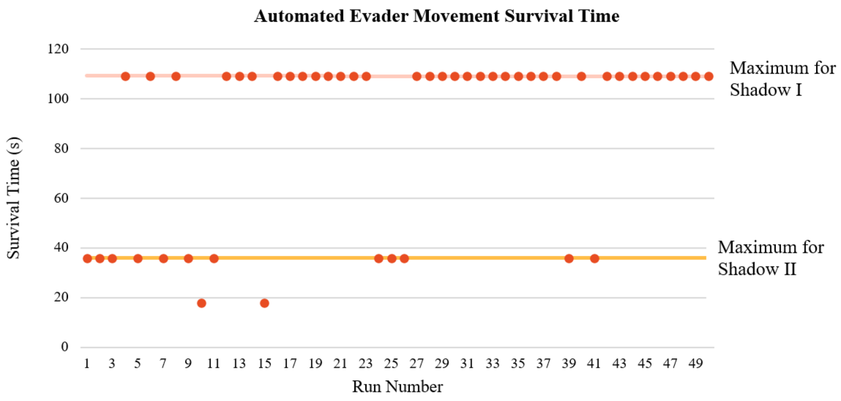
Data and Results



The above graph depicts the data generated by fifty trials of a human controlling an evader in the environment with the goal of remaining hidden for the maximum amount of time.

Results from **Human-Controlled Evader Movement**:

Starting Position	Maximum Survival Time	Range	Outliers
Shadow I	109.24 s	1.68 s	3
Shadow II	36.04 s	0.08 s	4



This graph illustrates the survival times resulting from fifty trials of computer-generated evader movement strategies.

Results from **Automated Evader Movement**:

Starting Position	Maximum Survival Time	Range	Outliers
Shadow I	109.12 s	0.00 s	0
Shadow II	35.92 s	0.00 s	2

Conclusion

- **Human-Controlled** Evader Movement has a maximum survival time that is slightly longer than the Automated Evader Movement.
- **Automated Evader Movement** has no variance in survival time for a given shadow containing the initial position.

Future Work

- None of the movement strategies analyzed in this research incorporated past or future states of the environment.
- Future work will investigate more types of possible movement strategies and different environments.
- Further research will create software that optimizes the amount of time an evader remains hidden.

Acknowledgements

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